Making Capital Investment Decisions 8

OPENING CASE

Everyone knows that computer chips evolve quickly, getting smaller, faster, and cheaper. In fact, the famous Moore's Law (named after Intel cofounder Gordon Moore) predicts that the number of transistors placed on a chip will double every two years (and this prediction has held up very well since it was published in 1965). This growth often means that companies need to build new fabrication facilities. For example, in 2015, GlobalFoundries announced that it was going to spend about $646 million to further expand its manufacturing plant in Saratoga, New York. The expansion at the plant would allow the company to produce more of its new 14 nanometer (nm) chips. Not to be outdone, IBM announced that it was investing $3 billion in a public-private partnership with New York State, GlobalFoundries, and Samsung in an effort to manufacture 7 nm chips, which would be smaller, faster, and consume less energy than current chips.

This chapter follows up on our previous one by delving more deeply into capital budgeting and the evaluation of projects such as these chip manufacturing facilities. We identify the relevant cash flows of a project, including initial investment outlays, requirements for net working capital, and operating cash flows. Further, we look at the effects of depreciation and taxes. We also examine the impact of inflation and show how to evaluate consistently the NPV analysis of a project.

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8.1 INCREMENTAL CASH FLOWS

Cash Flows—Not Accounting Income

You may not have thought about it, but there is a big difference between corporate finance courses and financial accounting courses. Techniques in corporate finance generally use cash flows, whereas financial accounting generally stresses income or earnings numbers. Certainly, our text follows this tradition, as our net present value techniques discount cash flows, not earnings. When considering a single project, we discount the cash flows that the firm receives from the project. When valuing the firm as a whole, we discount the cash flows—not earnings—that an investor receives.

EXAMPLE 8.1

Relevant Cash Flows

The Weber-Decker Co. just paid $1 million in cash for a building as part of a new capital budgeting project. This entire $1 million is an immediate cash outflow. However, assuming straight-line depreciation over 20 years, only $50,000 (= $1 million/20) is considered an accounting expense in the current year. Current earnings are thereby reduced by only $50,000. The remaining $950,000 is expensed over the following 19 years. For capital budgeting purposes, the relevant cash outflow at Date 0 is the full $1 million, not the reduction in earnings of only $50,000.

Always discount cash flows, not earnings, when performing a capital budgeting or valuation calculation. Earnings do not represent real money. You can't spend out of earnings, you can't eat out of earnings, and you can't pay dividends out of earnings. You can only do these things out of cash flow.

In addition, it is not enough to use cash flows. In calculating the NPV of a project, only cash flows that are *incremental* to the project should be used. These cash flows are the changes in the firm's cash flows that occur as a direct consequence of accepting the project. That is, we are interested in the difference between the cash flows of the firm with the project and the cash flows of the firm without the project.

The use of incremental cash flows sounds easy enough, but pitfalls abound in the real world. We describe below how to avoid some of the pitfalls of determining incremental cash flows.

Sunk Costs

A sunk cost is a cost that has already occurred. Because sunk costs are in the past, they cannot be changed by the decision to accept or reject the project. Just as we "let bygones be bygones," we should ignore such costs. Sunk costs are not incremental cash outflows.

EXAMPLE 8.2

Sunk Costs

The General Milk Company is currently evaluating the NPV of establishing a line of chocolate milk. As part of the evaluation, the company had paid a consulting firm $100,000 to perform a test-marketing analysis. This expenditure was made last year. Is this cost relevant for the capital budgeting decision now confronting the management of General Milk Company?

The answer is no. The $100,000 is not recoverable, so the $100,000 expenditure is a sunk cost, or spilled milk. Of course, the decision to spend $100,000 for a marketing analysis was a capital budgeting decision itself and was perfectly relevant *before* it was sunk. Our point is that once the company incurred the expense, the cost became irrelevant for any future decision.

Opportunity Costs

Your firm may have an asset that it is considering selling, leasing, or employing elsewhere in the business. If the asset is used in a new project, potential revenues from alternative uses are lost. These lost revenues can meaningfully be viewed as costs. They are called **opportunity costs** because, by taking the project, the firm forgoes other opportunities for using the assets.

EXAMPLE 8.3

Opportunity Costs

Suppose the Weinstein Trading Company has an empty warehouse in Philadelphia that can be used to store a new line of electronic pinball machines. The company hopes to sell these machines to affluent Northeastern consumers. Should the warehouse be considered a cost in the decision to sell the machines?

The answer is yes. The company could sell the warehouse if it decides not to market the pinball machines. Thus, the sales price of the warehouse is an opportunity cost in the pinball machine decision.

Side Effects

Another difficulty in determining incremental cash flows comes from the side effects of the proposed project on other parts of the firm. A side effect is classified as either **erosion** or **synergy**. Erosion occurs when a new product reduces the sales and, hence, the cash flows, of existing products. Synergy occurs when a new product increases the cash flows of existing projects.

EXAMPLE 8.4

Erosion versus Synergy

Suppose the Innovative Motors Corporation (IMC) is determining the NPV of a new convertible sports car. Some of the customers who would purchase the car are owners of IMC's compact sedans. Are all sales and profits from the new convertible sports car incremental?

The answer is no because some of the cash flow represents transfers from other elements of IMC's product line. This is erosion, which must be included in the NPV calculation. Without taking erosion into account, IMC might erroneously calculate the NPV of the sports car to be, say, $100 million. If half the customers are transfers from the sedan and lost sedan sales have an NPV of −$150 million, the true NPV is −$50 million (= $100 million − 150 million).

IMC is also contemplating the formation of a racing team. The team is forecasted to lose money for the foreseeable future, with perhaps the best projection showing an NPV of −$35 million for the operation. However, IMC's managers are aware that the team will likely generate great publicity for all of IMC's products. A consultant estimates that the increase in cash flows elsewhere in the firm has a present value of $65 million. Assuming that the consultant's estimates of synergy are trustworthy, the net present value of the team is $30 million (= $65 million − 35 million). The managers should form the team.

Allocated Costs

Frequently a particular expenditure benefits a number of projects. Accountants allocate this cost across the different projects when determining income. However, for capital budgeting purposes, this **allocated cost** should be viewed as a cash outflow of a project only if it is an incremental cost of the project.

EXAMPLE 8.5

Allocated Cost

The Voetmann Consulting Corp. devotes one wing of its suite of offices to a library requiring a cash outflow of $100,000 a year in upkeep. A proposed capital budgeting project is expected to generate revenue equal to 5 percent of the overall firm's sales. An executive at the firm, H. Sears, argues that $5,000 (= .05 × $100,000) should be viewed as the proposed project's share of the library's costs. Is this appropriate for capital budgeting?

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The answer is no. One must ask the question: What is the difference between the cash flows of the entire firm with the project and the cash flows of the entire firm without the project? The firm will spend $100,000 on library upkeep whether or not the proposed project is accepted. Since acceptance of the proposed project does not affect this cash flow, the cash flow should be ignored when calculating the NPV of the project.

8.2 THE BALDWIN COMPANY: AN EXAMPLE

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We next consider the example of a proposed investment in machinery and related items. Our example involves the Baldwin Company and colored bowling balls.

The Baldwin Company, originally established in 1965 to make footballs, is now a leading producer of tennis balls, baseballs, footballs, and golf balls. In 1973, the company introduced "High Flite," its first line of high-performance golf balls. The Baldwin management has sought opportunities in whatever businesses seem to have some potential for cash flow. In 2015, W. C. Meadows, vice president of the Baldwin Company, identified another segment of the sports ball market that looked promising and that he felt was not adequately served by larger manufacturers. That market was for brightly colored bowling balls, and he believed a large number of bowlers valued appearance and style above performance. He also believed that it would be difficult for competitors to take advantage of the opportunity because of both Baldwin's cost advantages and its highly developed marketing skills.

As a result, in early 2016, the Baldwin Company investigated the marketing potential of brightly colored bowling balls. Baldwin sent a questionnaire to consumers in three markets: Philadelphia, Los Angeles, and New Haven. The results of the three questionnaires were much better than expected and supported the conclusion that the brightly colored bowling balls could achieve a 10 to 15 percent share of the market. Of course, some people at Baldwin complained about the cost of the test marketing, which was $250,000. (As we shall see later, this is a sunk cost and should not be included in project evaluation.)

In any case, the Baldwin Company is now considering investing in a machine to produce bowling balls. The bowling balls would be manufactured in a building owned by the firm and located near Los Angeles. This building, which is vacant, and the land can be sold for $150,000 after taxes.

Working with his staff, Meadows is preparing an analysis of the proposed new product. He summarizes his assumptions as follows: The cost of the bowling ball machine is $100,000. The machine has an estimated market value at the end of five years of $30,000. Production by year during the five-year life of the machine is expected to be as follows: 5,000 units, 8,000 units, 12,000 units, 10,000 units, and 6,000 units. The price of bowling balls in the first year will be $20. The bowling ball market is highly competitive, so Meadows believes that the price of bowling balls will increase at only 2 percent per year, as compared to the anticipated general inflation rate of 5 percent. Conversely, the plastic used to produce bowling balls is rapidly becoming more expensive. Because of this, production cash outflows are expected to grow at 10 percent per year. First-year production costs will be $10 per unit. Meadows has determined, based upon Baldwin's taxable income, that the appropriate incremental corporate tax rate in the bowling ball project is 34 percent.

Net working capital is defined as the difference between current assets and current liabilities. Like any other manufacturing firm, Baldwin finds that it must maintain an investment in working capital. It will purchase raw materials before production and sale, giving rise to an investment in inventory. It will maintain cash as a buffer against unforeseen expenditures. And its credit sales will generate accounts receivable. Management determines that an immediate (Year 0) investment in the different items of working capital of $10,000 is required. The total net working capital for each subsequent year will be 10 percent of sales. Working capital is forecast to rise in the early years of the project but to fall to $0 by the project's end. In other words, the investment in working capital is to be completely recovered by the end of the project's life.

Projections based on these assumptions and Meadows' analysis appear in Tables 8.1 through 8.4. In these tables all cash flows are assumed to occur at the *end* of the year. Because of the large amount of information in these tables, it is important to see how the tables are related. Table 8.1 shows the basic data for both investment and income. Supplementary schedules on operations and depreciation, as presented in Tables 8.2 and 8.3, help explain where the numbers in Table 8.1 come from. Our goal is to obtain projections of cash flow. The data in Table 8.1 are all that are needed to calculate the relevant cash flows, as shown in Table 8.4.

TABLE 8.1 The Worksheet for Cash Flows of the Baldwin Company (in $ thousands)

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Investments:						
(1) Bowling ball machine	– $100.00					$ 21.76*
(2) Accumulated depreciation		$ 20.00	$ 52.00	$ 71.20	$ 82.72	94.24
(3) Adjusted basis of machine after depreciation (end of year)		80.00	48.00	28.80	17.28	5.76
(4) Opportunity cost (warehouse)	– 150.00					150.00
(5) Net working capital (end of year)	10.00	10.00	16.32	24.97	21.22	0
(6) Change in networking capital	– 10.00		– 6.32	– 8.65	3.75	21.22
(7) Total cash flow of investment [(1) + (4) + (6)]	– 260.00		– 6.32	– 8.65	3.75	192.98
Income:						
(8) Sales revenues		$100.00	$163.20	$249.72	$212.20	$129.90
(9) Operating costs		– 50.00	– 88.00	– 145.20	– 133.10	– 87.84
(10) Depreciation		– 20.00	– 32.00	– 19.20	– 11.52	– 11.52
(11) Income before taxes [(8) + (9) + (10)]		30.00	43.20	85.32	67.58	30.54

(12) Tax at 34%	− 10.20	− 14.69	− 29.01	− 22.98	− 10.38
(13) Net income	19.80	28.51	56.31	44.60	20.16

Note: All cash flows occur at the end of the year. Also, you should notice that the cash flows are rounded to two decimals for ease of exposition. Those who use spreadsheets such as Microsoft Excel™ will find very small rounding differences.

* We assume that the ending market value of the capital investment at Year 5 is $30 (in thousands). The taxable amount is $24.24 (= $30 − 5.76). The aftertax salvage value is $30 − [.34 × ($30 − 5.76)] = 21.76.

An Analysis of the Project

INVESTMENTS The investment outlays for the project are summarized in the top segment of Table 8.1. They consist of three parts:

1. *The Bowling Ball Machine.* The purchase requires an immediate (Year 0) cash outflow of $100,000. The firm realizes a cash inflow when the machine is sold in Year 5. These cash flows are shown in Line 1 of Table 8.1. As indicated in the footnote to the table, taxes are incurred when the asset is sold.
2. *The Opportunity Cost of Not Selling the Warehouse.* If Baldwin accepts the bowling ball project, it will use a warehouse and land that could otherwise be sold. The estimated sales price of the warehouse and land is therefore included as an *opportunity cost* in Year 0, as presented in Line 4. Opportunity costs are treated as cash outflows for purposes of capital budgeting. However, note that if the project is accepted, management assumes that the warehouse will be sold for $150,000 (after taxes) in Year 5.

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3. *The Investment in Working Capital.* Required working capital appears in Line 5. Working capital rises over the early years of the project as expansion occurs. However, all working capital is assumed to be recovered at the end, a common assumption in capital budgeting. In other words, all inventory is sold by the end, the cash balance maintained as a buffer is liquidated, and all accounts receivable are collected. Increases in working capital in the early years must be funded by cash generated elsewhere in the firm. Hence, these increases are viewed as cash *outflows.* To reiterate, it is the *increase* in working capital over a year that leads to a cash outflow in that year. Even if working capital is at a high level, there will be no cash outflow over a year if working capital stays constant over that year. Conversely, decreases in working capital in the later years are viewed as cash inflows. All of these cash flows are presented in Line 6. A more complete discussion of working capital is provided later in this section.

   To recap, there are three investments in this example: the bowling ball machine (Line 1 in Table 8.1), the opportunity cost of the warehouse (Line 4), and the changes in working capital (Line 6). The total cash flow from the above three investments is shown in line 7.

   The test-marketing cost of $250,000 is not included. The tests occurred in the past and should be viewed as a *sunk cost.*

INCOME AND TAXES Next, the determination of income is presented in the bottom segment of Table 8.1. While we are ultimately interested in cash flow—not income—we need the income calculation in order to determine taxes. Lines 8 and 9 of Table 8.1 show sales revenues and operating costs, respectively. The projections in these lines are based on the sales revenues and operating costs computed in columns 4 and 6 of Table 8.2. The estimates of revenues and costs follow from assumptions made by the corporate planning staff at Baldwin. In other words, the estimates critically depend on the fact that product prices are projected to increase at 2 percent per year and costs per unit are projected to increase at 10 percent per year.

Depreciation of the $100,000 capital investment is shown in Line 10 of Table 8.1. Where do these numbers come from? Depreciation for tax purposes for U.S. companies is based on the Modified Accelerated Cost Recovery System (MACRS). Each asset is assigned a useful life under MACRS, with an accompanying depreciation schedule as shown in Table 8.3. The IRS ruled that Baldwin is to depreciate its capital investment over five years, so the second column of the table applies in this case. Since depreciation in the table is expressed as a percentage of the asset's cost, multiply the percentages in this column by $100,000 to arrive at depreciation in dollars.

Income before taxes is calculated in Line 11 of Table 8.1. Taxes are provided in Line 12 of this table, and net income is calculated in Line 13.

TABLE 8.2 Operating Revenues and Costs of the Baldwin Company

(1)	(2)	(3)	(4)	(5)	(6)
YEAR	**PRODUCTION**	**PRICE**	**SALES REVENUES**	**COST PER UNIT**	**OPERATING COSTS**
1	5,000	$20.00	$100,000	$10.00	$ 50,000

2	8,000	20.40	163,200	11.00	88,000
3	12,000	20.81	249,720	12.10	145,200
4	10,000	21.22	212,200	13.31	133,100
5	6,000	21.65	129,900	14.64	87,840

Prices rise at 2 percent per year.

Unit costs rise at 10 percent per year.

TABLE 8.3 Depreciation under Modified Accelerated Cost Recovery System (MACRS)

	RECOVERY PERIOD CLASS					
YEAR	3 YEARS	5 YEARS	7 YEARS	10 YEARS	15 YEARS	20 YEARS
1	.3333	.2000	.1429	.1000	.0500	.03750
2	.4445	.3200	.2449	.1800	.0950	.07219
3	.1481	.1920	.1749	.1440	.0855	.06677
4	.0741	.1152	.1249	.1152	.0770	.06177
5		.1152	.0893	.0922	.0693	.05713
6		.0576	.0892	.0737	.0623	.05285
7			.0893	.0655	.0590	.04888
8			.0446	.0655	.0590	.04522
9				.0656	.0591	.04462
10				.0655	.0590	.04461
11				.0328	.0591	.04462
12					.0590	.04461
13					.0591	.04462
14					.0590	.04461
15					.0591	.04462
16					.0295	.04461
17						.04462
18						.04461
19						.04462
20						.04461
21						.02231

Depreciation is expressed as a percent of the asset's cost. These schedules are based on the IRS Publication 946: *How to Depreciate Property* and other details on depreciation are presented later in the chapter. Note that five-year depreciation actually carries over six years because the IRS assumes purchase is made in midyear.

SALVAGE VALUE In calculating depreciation under current tax law, the expected economic life and future value of an asset are not issues. As a result, the book value of an asset can differ substantially from its actual market value. For example, consider the bowling ball machine the Baldwin Company is considering for its new project. The book value after the first year is $100,000 less the first year's depreciation of $20,000, or $80,000. After six years, the book value of the machine is zero.

Suppose, at the end of the project, Baldwin sold the machine. At the end of the fifth year, the book value of the machine would be $5,760, but based on Baldwin's experience, it would probably be worth about $30,000. If the company actually sold it for this amount, then it would pay taxes at the ordinary income tax rate on the difference between the sale price of $30,000 and the book value of $5,760. With a 34 percent tax rate, the tax liability would be .34 × ($30,000 − 5,760) = $8,241.60. So, the aftertax salvage value of the equipment, a cash inflow to the company, would be $30,000 − 8,241.60 = $21,758.40.

Taxes must be paid in this case because the difference between the market value and the book value is "excess" depreciation, and it must be "recaptured" when the asset is sold. In this case, Baldwin would have overdepreciated the asset by $30,000 − 5,760 = $24,240. Because the depreciation was too high, the company paid too little in taxes.

Notice this is not a tax on a long-term capital gain. Further, what is and what is not a capital gain is ultimately up to taxing authorities, and the specific rules can be very complex. We will ignore capital gains taxes for the most part.

Finally, if the book value exceeds the market value, then the difference is treated as a loss for tax purposes. For example, if Baldwin sold the machine for $4,000, then the book value would exceed the market value by $1,760. In this case, a tax savings of .34 × $1,760 = $598.40 would occur.

TABLE 8.4 Incremental Cash Flows for the Baldwin Company (in $ thousands)

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
(1) Sales revenue [Line 8, Table 8.1]		$100.00	$163.20	$249.72	$212.20	$129.90
(2) Operating costs [Line 9, Table 8.1]		−50.00	−88.00	−145.20	−133.10	−87.84
(3) Taxes [Line 12, Table 8.1]		−10.20	−14.69	− 29.01	− 22.98	−10.38
(4) Operating cash flow [(1) + (2) + (3)]		39.80	60.51	75.51	56.12	31.68
(5) Total cash flow of investment [Line 7, Table 8.1]	−$260.00		− 6.32	− 8.65	3.75	192.98
(6) Total cash flow of project [(4) + (5)]	− 260.00	39.80	54.19	66.86	59.87	224.66

NPV @		
	4%	$123.641
	10	51.588
	15	5.472
	15.67	0
	20	−31.351

CASH FLOW Cash flow is finally determined in Table 8.4. We begin by reproducing Lines 8, 9, and 12 in Table 8.1 as Lines 1, 2, and 3 in Table 8.4. Operating cash flow, which is sales minus both operating costs and taxes, is provided in Line 4 of Table 8.4. Total investment cash flow, taken from Line 7 of Table 8.1, appears as Line 5 of Table 8.4. Cash flow from operations plus total cash flow of the investment equals total cash flow of the project, which is displayed as Line 6 of Table 8.4. We should note that the cash flows we have calculated here are simply the cash flow from assets we calculated in Chapter 2.

NET PRESENT VALUE The NPV of the Baldwin bowling ball project can be calculated from the cash flows in Line 6. This is often referred to as unlevered free cash flow. The word *unlevered* means that the cash flows are independent of any debt that may have been used to finance the project. The word *free* refers to the fact that these cash flows can be distributed to creditors and shareholders. As can be seen at the bottom of Table 8.4, the NPV is $51,588 if 10 percent is the appropriate discount rate and −$31,351 if 20 percent is the appropriate discount rate. If the discount rate is 15.67 percent, the project will have a zero NPV. In other words, the project's internal rate of return is 15.67 percent. If the discount rate of the Baldwin bowling ball project is above 15.67 percent, it should not be accepted because its NPV would be negative.

Which Set of Books?

It should be noted that the firm's management generally keeps two sets of books, one for the IRS (called the *tax books)* and another for its annual report (called the *stockholders' books).* The tax books follow the rules of the IRS. The stockholders' books follow the rules of the *Financial Accounting Standards Board* (FASB), the governing body in accounting. The two sets of rules differ widely in certain areas. For example, income on municipal bonds is ignored for tax purposes while being treated as income by the FASB. The differences almost always benefit the firm, because the rules permit income on the stockholders' books to be higher than income on the tax books. That is, management can look profitable to the stockholders without needing to pay taxes on all of the reported profit. In fact, there are plenty of large companies that consistently report positive earnings to the stockholders while reporting losses to the IRS.

A Note on Net Working Capital

The investment in net working capital is an important part of any capital budgeting analysis.[1] While we explicitly considered net working capital in Lines 5 and 6 of Table 8.1, students may be wondering where the numbers in these lines came from. Examples of investments in net working capital arise whenever (1) inventory is purchased, (2) cash is kept in the project as a buffer against unexpected expenditures, and (3) credit sales are made, generating accounts receivable rather than cash. (The investment in net working capital is reduced by credit purchases, which generate accounts payable.) This investment in net working capital represents a cash outflow, because cash generated elsewhere in the firm is tied up in the project.

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To see how the investment in net working capital is built from its component parts, we focus on Year 1. We see in Table 8.1 that Baldwin's managers predict sales in Year 1 to be \$100,000 and operating costs to be \$50,000. If both the sales and costs were cash transactions, the firm would receive \$50,000 (= \$100,000 − 50,000). As stated earlier, this cash flow would occur at the *end* of Year 1.

Now let's give you more information. The managers:

1. Forecast that \$9,000 of the sales will be on credit, implying that cash receipts at the end of Year 1 will be only \$91,000 (= \$100,000 − 9,000). The accounts receivable of \$9,000 will be collected at the end of Year 2.
2. Believe that they can defer payment on \$3,000 of the \$50,000 of costs, implying that cash disbursements at the end of Year 1 will be only \$47,000 (= \$50,000 − 3,000). Baldwin will pay off the \$3,000 of accounts payable at the end of Year 2.
3. Decide that inventory of \$2,500 should be left on hand at the end of Year 1 to avoid *stockouts* (that is, running out of inventory).
4. Decide that cash of \$1,500 should be earmarked for the project at the end of Year 1 to avoid running out of cash.

Thus, net working capital at the end of Year 1 is:

\$9,000	**−**	**\$3,000**	**+**	**\$2,500**	**+**	**\$1,500**	**=**	**\$10,000**
Accounts receivable		**Accounts payable**		**Inventory**		**Cash**		**Net working capital**

Because \$10,000 of cash generated elsewhere in the firm must be used to offset this requirement for net working capital, Baldwin's managers correctly view the investment in net working capital as a cash outflow of the project. As the project grows over time, needs for net working capital increase. *Changes* in net working capital from year to year represent further cash flows, as indicated by the negative numbers for the first few years of Line 6 of Table 8.1. However, in the declining years of the project, net working capital is reduced—ultimately to zero. That is, accounts receivable are finally collected, the project's cash buffer is returned to the rest of the corporation, and all remaining inventory is sold off. This frees up cash in the later years, as indicated by positive numbers in Years 4 and 5 of Line 6.

Typically, corporate worksheets (such as Table 8.1) treat net working capital as a whole. The individual components of working capital (receivables, inventory, etc.) do not generally appear in the worksheets. However, the reader should remember that the working capital numbers in the worksheets are not pulled out of thin air. Rather, they result from a meticulous forecast of the components, just as we illustrated for Year 1.

A Note on Depreciation

The Baldwin case made some assumptions about depreciation. Where did these assumptions come from? Assets are currently depreciated for tax purposes according to the provisions of the 1986 Tax Reform Act. There are seven classes of depreciable property:

1. The three-year class includes certain specialized short-lived property. Tractor units and racehorses over two years old are among the very few items fitting into this class.
2. The five-year class includes (a) cars and trucks; (b) computers and peripheral equipment, as well as calculators, copiers, and typewriters; and (c) specific items used for research purposes.

3. The seven-year class includes office furniture, equipment, books, and single-purpose agricultural structures. It is also a catchall category, because any asset not designated to be in another class is included here.
4. The 10-year class includes vessels, barges, tugs, and similar equipment related to water transportation.
5. The 15-year class encompasses a variety of specialized items. Included are equipment of telephone distribution plants and similar equipment used for voice and data communications, and sewage treatment plants.
6. The 20-year class includes farm buildings, sewer pipe, and other very long-lived equipment.
7. Real property that is depreciable is separated into two classes: residential and nonresidential. The cost of residential property is recovered over 27 ½ years and nonresidential property over 31 ½ years.

Items in the three-, five-, and seven-year classes are depreciated using the 200 percent declining-balance method, with a switch to straight-line depreciation at a point specified in the Tax Reform Act. Items in the 15- and 20-year classes are depreciated using the 150 percent declining-balance method, with a switch to straight-line depreciation at a specified point. All real estate is depreciated on a straight-line basis.

All calculations of depreciation include a half-year convention, which treats all property as if it were placed in service at midyear. To be consistent, the IRS allows half a year of depreciation for the year in which property is disposed of or retired. The effect of this is to spread the deductions for property over one year more than the name of its class, for example, six tax years for five-year property.

Interest Expense

It may have bothered you that interest expense was ignored in the Baldwin example. After all, many projects are at least partially financed with debt, particularly a bowling ball machine that is likely to increase the debt capacity of the firm. As it turns out, our approach of assuming no debt financing is rather standard in the real world. Firms typically calculate a project's cash flows under the assumption that the project is financed only with equity. Any adjustments for debt financing are reflected in the discount rate, not the cash flows. The treatment of debt in capital budgeting will be covered in depth later in the text (especially in Chapter 12). Suffice it to say at this time that the full ramifications of debt financing are well beyond our current discussion.

8.3 INFLATION AND CAPITAL BUDGETING

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Inflation is an important fact of economic life, and it must be considered in capital budgeting. Capital budgeting requires data on cash flows as well as on interest rates. Like interest rates, cash flows can be expressed in either nominal or real terms. A **nominal cash flow** refers to the actual dollars to be received (or paid out). A **real cash flow** refers to the cash flow's purchasing power. Like most definitions, these definitions are best explained by examples.

EXAMPLE 8.6

Nominal versus Real Cash Flow

Burrows Publishing has just purchased the rights to the next book of famed romantic novelist Barbara Musk. Still unwritten, the book should be available to the public in four years. Currently, romantic novels sell for $10.00 in softcover. The publishers believe that inflation will be 6 percent per year over the next four years. Since romantic novels are so popular, the publishers anticipate that their prices will rise about 2 percent per year more than the inflation rate over the next four years. Burrows Publishing plans to sell the novel at a price of $13.60 (= $1.08^4 \times$ $10.00) four years from now, anticipating sales of 100,000 copies.

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The expected cash flow in the fourth year of $1.36 million (= $13.60 × 100,000) is a *nominal cash flow*. That is, the firm expects to receive $1.36 million at that time. In other words, a nominal cash flow refers to the actual dollars to be received in the future.

The purchasing power of $1.36 million in four years is determined by deflating the $1.36 million at 6 percent for four years:

$$\$1.08 \text{ million} = \frac{\$1.36 \text{ million}}{(1.06)^4}$$

The figure, $1.08 million, is a *real cash flow* since it is expressed in terms of purchasing power.

EXAMPLE 8.7

Depreciation

EOBII Publishers, a competitor of Burrows, recently bought a printing press for $2,000,000 to be depreciated by the straight-line method over five years. This implies yearly depreciation of $400,000 (= $2,000,000/5). Is this $400,000 figure a real or a nominal quantity?

Depreciation is a *nominal* quantity because $400,000 is the actual tax deduction over each of the next four years. Depreciation becomes a real quantity if it is adjusted for purchasing power. Hence, $316,837 (= $400,000/1.06^4) is depreciation in the fourth year, expressed as a real quantity.

Discounting: Nominal or Real?

Our examples show that cash flows can be expressed in either nominal or real terms. Given these choices, how should one express discount rates and cash flows when performing capital budgeting?

Financial practitioners correctly stress the need to maintain *consistency* between cash flows and discount rates. That is:

***Nominal* cash flows must be discounted at the *nominal* rate.**
***Real* cash flows must be discounted at the *real* rate.**

As long as one is consistent, either approach is correct. In order to minimize computational error, it is generally advisable in practice to choose the approach that is easiest. This idea is illustrated in the following two examples.

EXAMPLE 8.8

Real and Nominal Discounting

Shields Electric forecasts the following nominal cash flows on a particular project:

DATE	0	1	2

CASH FLOW	−$1,000	$600	$650

The nominal discount rate is 14 percent, and the inflation rate is forecast to be 5 percent. What is the value of the project?

Using Nominal Quantities The NPV can be calculated as:

$$\$26.47 = -\$1{,}000 + \frac{\$600}{1.14} + \frac{\$650}{(1.14)^2}$$

The project should be accepted.

Mr. Altshuler forecasts all cash flows in *nominal* terms, leading to the following spreadsheet:

	YEAR		
	0	1	2
Capital expenditure	−$1,210		
Revenues		$2,090 (= $1,900 × 1.10)	$2,420 [= $2,000 × $(1.10)^2$]
−Expenses		− 1,045 (= $950 × 1.10)	− 1,210 [= $1,000 × $(1.10)^2$]
−Depreciation		− 605 (=$1,210/2)	− 605
Taxable income		$ 440	$ 605
−Taxes (40%)		− 176	− 242
Income after taxes		$ 264	$ 363
+ Depreciation		+ 605	+ 605
Cash flow		$ 869	$ 968

$$\text{NPV} = -\$1{,}210 + \frac{\$869}{1.155} + \frac{\$968}{(1.155)^2} = \$268$$

Mr. Altshuler's sidekick, Stuart Weiss, prefers working in real terms. He first calculates the real rate to be 5 percent (= 1.155/1.10 − 1). Next, he generates the following spreadsheet in *real* quantities:

	YEAR		
	0	1	2
Capital expenditure	−$1,210		
Revenues		$1,900	$2,000
−Expenses		− 950	− 1,000
−Depreciation		− 550 (=$605/1.1)	− 500 (=$605/1.1^2)
Taxable income		$ 400	$ 500
−Taxes (40%)		− 160	− 200
Income after taxes		$ 240	$ 300
+ Depreciation		+ 550	+ 500
Cash flow		$ 790	$ 800

$$\text{NPV} = -\$1{,}210 + \frac{\$790}{1.05} + \frac{\$800}{(1.05)^2} = \$268$$

In explaining his calculations to Mr. Altshuler, Mr. Weiss points out:

1. Since the capital expenditure occurs at Date 0 (today), its nominal value and its real value are equal.
2. Because yearly depreciation of $605 is a nominal value, one converts it to a real value by discounting at the inflation rate of 10 percent.

It is no coincidence that both Mr. Altshuler and Mr. Weiss arrive at the same NPV number. Both methods must always generate the same NPV.

8.4 ALTERNATIVE DEFINITIONS OF OPERATING CASH FLOW

The analysis we went through in the previous section is quite general and can be adapted to just about any capital investment problem. In the next section, we illustrate a particularly useful variation. Before we do so, we need to discuss the fact that there are different definitions of project operating cash flow that are commonly used, both in practice and in finance texts.

As we will see, the different approaches to operating cash flow that exist all measure the same thing. If they are used correctly, they all produce the same answer, and one is not necessarily any better or more useful than another. Unfortunately, the fact that alternative definitions are used does sometimes lead to confusion. For this reason, we examine several of these variations next to see how they are related.

In the discussion that follows, keep in mind that when we speak of cash flow, we literally mean dollars in less dollars out. This is all we are concerned with. Different definitions of operating cash flow simply amount to different ways of manipulating basic information about sales, costs, depreciation, and taxes to get at cash flow.

For a particular project and year under consideration, suppose we have the following estimates:

Sales = $1,500

Costs = $700

Depreciation = $600

With these estimates, notice that EBIT is:

EBIT = Sales − Costs − Depreciation

= $1,500 − 700 − 600

= $200

Once again, we assume that no interest is paid, so the tax bill is:

$$\text{Taxes} = \text{EBIT} \times t_c$$
$$= \$200 \times .34 = \$68$$

where t_c, the corporate tax rate, is 34 percent.

When we put all of this together, we see that project operating cash flow, OCF, is:

$$\text{OCF} = \text{EBIT} + \text{Depreciation} - \text{Taxes}$$
$$= \$200 + 600 - 68 = \$732$$

It turns out there are some other ways to determine OCF that could be (and are) used. We consider these next.

The Bottom-Up Approach

Because we are ignoring any financing expenses, such as interest, in our calculations of project OCF, we can write project net income as:

$$\text{Project net income} = \text{EBIT} - \text{Taxes}$$
$$= \$200 - 68$$
$$= \$132$$

If we simply add the depreciation to both sides, we arrive at a slightly different and very common expression for OCF:

$$\text{OCF} = \text{Net income} + \text{Depreciation} \qquad [8.1]$$
$$= \$132 + 600$$
$$= \$732$$

This is the *bottom-up* approach. Here, we start with the accountant's bottom line (net income) and add back any noncash deductions such as depreciation. It is crucial to remember that this definition of operating cash flow as net income plus depreciation is correct only if there is no interest expense subtracted in the calculation of net income.

The Top-Down Approach

Perhaps the most obvious way to calculate OCF is:

We could consider many other special cases, but these three are particularly important because problems similar to these are so common. Also, they illustrate some diverse applications of cash flow analysis and DCF valuation.

Setting the Bid Price

Early on, we used discounted cash flow analysis to evaluate a proposed new product. A somewhat different (and common) scenario arises when we must submit a competitive bid to win a job. Under such circumstances, the winner is whoever submits the lowest bid.

There is an old joke concerning this process: The low bidder is whoever makes the biggest mistake. This is called the winner's curse. In other words, if you win, there is a good chance you underbid. In this section, we look at how to go about setting the bid price to avoid the winner's curse. The procedure we describe is useful anytime we have to set a price on a product or service.

To illustrate how to go about setting a bid price, imagine we are in the business of buying stripped-down truck platforms and then modifying them to customer specifications for resale. A local distributor has requested bids for five specially modified trucks each year for the next four years, for a total of 20 trucks in all.

We need to decide what price per truck to bid. The goal of our analysis is to determine the lowest price we can profitably charge. This maximizes our chances of being awarded the contract while guarding against the winner's curse.

Suppose we can buy the truck platforms for $10,000 each. The facilities we need can be leased for $24,000 per year. The labor and material cost to do the modification works out to be about $4,000 per truck. Total cost per year will thus be $24,000 + 5 × (10,000 + 4,000) = $94,000.

We will need to invest $60,000 in new equipment. This equipment will be depreciated straight-line to a zero salvage value over the four years. It will be worth about $5,000 at the end of that time. We will also need to invest $40,000 in raw materials inventory and other working capital items. The relevant tax rate is 39 percent. What price per truck should we bid if we require a 20 percent return on our investment?

We start by looking at the capital spending and net working capital investment. We have to spend $60,000 today for new equipment. The aftertax salvage value is $5,000(1 − .39) = $3,050. Furthermore, we have to invest $40,000 today in working capital. We will get this back in four years.

We can't determine the operating cash flow just yet because we don't know the sales price. Thus, if we draw a time line, here is what we have so far:

	YEAR				
	0	1	2	3	4
Operating cash flow		+OCF	+OCF	+OCF	+OCF
Change in NWC	−$ 40,000				−$40,000
Capital spending	−60,000				3,050
Total case flow	−$100,000	+OCF	+OCF	+OCF	+OCF + $43,050

With this in mind, note that the key observation is the following: The lowest possible price we can profitably charge will result in a zero NPV at 20 percent. At that price, we earn exactly 20 percent on our investment.

Given this observation, we first need to determine what the operating cash flow must be for the NPV to equal zero. To do this, we calculate the present value of the $43,050 nonoperating cash flow from the last year and subtract it from the $100,000 initial investment:

$$\$100{,}000 - 43{,}050/1.20^4 = \$100{,}000 - 20{,}761 = \$79{,}239$$

Once we have done this, our time line is as follows:

	YEAR				
	0	1	2	3	4
Total case flow	−$79,239	+OCF	+OCF	+OCF	+OCF

As the time line suggests, the operating cash flow is now an unknown ordinary annuity amount. The four-year annuity factor for 20 percent is 2.58873, so we have:

$$\text{NPV} = 0 = -\$79{,}239 + \text{OCF} \times 2.58873$$

This implies that:

$$\text{OCF} = \$79{,}239/2.58873 = \$30{,}609$$

So the operating cash flow needs to be $30,609 each year.

We're not quite finished. The final problem is to find out what sales price results in an operating cash flow of $30,609. The easiest way to do this is to recall that operating cash flow can be written as net income plus depreciation (the bottom-up definition). The depreciation here is $60,000/4 = $15,000. Given this, we can determine what net income must be:

Operating cash flow = Net income + Depreciation
$30,609 = Net income + $15,000
Net income = $15,609

From here, we work our way backward up the income statement. If net income is $15,609, then our income statement is as follows:

Sales	?
Costs	$94,000
Depreciation	15,000
Taxes (39%)	?
Net income	$15,609

We can solve for sales by noting that:

$$\textbf{Net income} = (\textbf{Sales} - \textbf{Costs} - \textbf{Depreciation}) \times (1 - t_C)$$
$$\$15{,}609 = (\text{Sales} - \$94{,}000 - 15{,}000) \times (1 - .39)$$
$$\text{Sales} = \$15{,}609/.61 + 94{,}000 + 15{,}000$$
$$\text{Sales} = \$134{,}589$$

Sales per year must be $134,589. Because the contract calls for five trucks per year, the sales price has to be $134,589/5 = $26,918. If we round this up a bit, it looks as though we need to bid about $27,000 per truck. At this price, were we to get the contract, our return would be just over 20 percent.

Evaluating Equipment Options with Different Lives

Suppose a firm must choose between two machines of unequal lives. Both machines can do the same job, but they have different operating costs and will last for different time periods. A simple application of the NPV rule suggests taking the machine whose costs have the lower present value. This choice might be a mistake, however, because the lower-cost machine may need to be replaced before the other one.

Let's consider an example. The Downtown Athletic Club must choose between two mechanical tennis ball throwers. Machine *A* costs less than Machine *B* but will not last as long. The aftertax cash *outflows* from the two machines are

	DATE				
MACHINE	0	1	2	3	4
A	$500	$120	$120	$120	
B	600	100	100	100	$100

Machine *A* costs $500 and lasts three years. There will be aftertax maintenance expenses of $120 to be paid at the end of each of the three years. Machine *B* costs $600 and lasts four years. There will be aftertax maintenance expenses of $100 to be paid at the end of each of the four years. We place all costs in real terms, an assumption that greatly simplifies the analysis. Revenues per year are assumed to be the same, regardless of machine, so they are ignored in the analysis. Note that all numbers in the above chart are aftertax *outflows.*

To get a handle on the decision, let's take the present value of the costs of each of the two machines. Assuming a discount rate of 10 percent, we have:

$$\text{Machine } A\text{: } \$798.42 = \$500 + \frac{\$120}{1.1} + \frac{\$120}{(1.1)^2} + \frac{\$120}{(1.1)^3}$$

$$\text{Machine } B\text{: } \$916.99 = \$600 + \frac{\$100}{1.1} + \frac{\$100}{(1.1)^2} + \frac{\$100}{(1.1)^3} + \frac{\$100}{(1.1)^4}$$

Machine *B* has a higher present value of outflows. A naive approach would be to select Machine *A* because of its lower present value. However, Machine *B* has a longer life so perhaps its cost per year is actually lower.

How might one properly adjust for the difference in useful life when comparing the two machines? Perhaps the easiest approach involves calculating something called the *equivalent annual cost* of each machine. This approach puts costs on a per-year basis.

The above equation showed that payments of ($500, $120, $120, $120) are equivalent to a single payment of $798.42 at Date 0. We now wish to equate the single payment of $798.42 at Date 0 with a three-year annuity. Using techniques of previous chapters, we have:

$$\$798.42 = C \times \text{PVIFA}_{10\%,3}$$

$\text{PVIFA}_{10\%,3}$ is an annuity of $1 a year for three years, discounted at 10 percent, or $(1 - 1/1.10^3)/.10$. *C* is the unknown—the annuity payment per year such that the present value of all payments equals $798.42. Because $\text{PVIFA}_{10\%,3}$ equals 2.4869, *C* equals $321.06 (= $798.42/2.4869). Thus, a payment stream of ($500, $120, $120, $120) is equivalent to annuity payments of $321.06 made at the *end* of each year for three years. We refer to $321.06 as the *equivalent annual cost* of Machine A.

This idea is summarized in the chart below:

	DATE			
	0	1	2	3
Cash outflows of Machine *A*	$500	$120	$120	$120
Equivalent annual cost of Machine *A*		321.06	321.06	321.06

The Downtown Athletic Club should be indifferent between cash outflows of ($500, $120, $120, $120) and cash outflows of ($0, $321.06, $321.06, $321.06). Alternatively, one can say that the purchase of the machine is financially equivalent to a rental agreement calling for annual lease payments of $321.06.

Now let's turn to Machine *B.* We calculate its equivalent annual cost from:

$$\$916.99 = C \times PVIFA_{10\%,4}$$

Because PVIFA10%, 4 equals 3.1699, *C* equals $916.99/3.1699, or $289.28.

As we did above for Machine *A*, the following chart can be created for Machine *B*:

	DATE				
	0	1	2	3	4
Cash outflows of Machine *B*	$600	$100	$100	$100	$100
Equivalent annual cost of Machine *B*		289.28	289.28	289.28	289.28

The decision is easy once the charts of the two machines are compared. Would you rather make annual lease payments of $321.06 or $289.28? Put this way, the problem becomes a no-brainer. Clearly, a rational person would rather pay the lower amount. Thus, Machine *B* is the preferred choice.

Two final remarks are in order. First, it is no accident that we specified the costs of the tennis ball machines in real terms. While *B* would still have been the preferred machine had the costs been stated in nominal terms, the actual solution would have been much more difficult. As a general rule, always convert cash flows to real terms when working through problems of this type.

Second, the above analysis applies only if one anticipates that both machines can be replaced. The analysis would differ if no replacement were possible. For example, imagine that the only company that manufactured tennis ball throwers just went out of business and no new producers are expected to enter the field. In this case, Machine *B* would generate revenues in the fourth year whereas Machine *A* would not. Here, simple net present value analysis for mutually exclusive projects including both revenues and costs would be appropriate.

The General Decision to Replace

The previous analysis concerned the choice between Machine *A* and Machine *B*, both of which were new acquisitions. More typically, firms must decide when to replace an existing machine with a new one. This decision is actually quite straightforward. One should replace if the annual cost of the new machine is less than the annual cost of the old machine. As with much else in finance, an example clarifies this approach better than further explanation.

EXAMPLE 8.10

Replacement Decisions

Consider the situation of BIKE, which must decide whether to replace an existing machine. BIKE currently pays no taxes. The replacement machine costs $9,000 now and requires maintenance of $1,000 at the end of every year for eight years. At the end of eight years, the machine would be sold for $2,000.

The existing machine requires increasing amounts of maintenance each year, and its salvage value falls each year, as shown:

YEAR	MAINTENANCE	SALVAGE
Present	$ 0	$4,000
1	1,000	2,500
2	2,000	1,500
3	3,000	1,000
4	4,000	0

This chart tells us that the existing machine can be sold for $4,000 now. If it is sold one year from now, the resale price will be $2,500, and $1,000 must be spent on maintenance during the year to keep it running. For ease of calculation, we assume that this maintenance fee is paid at the end of the year. The machine will last for four more years before it falls apart. In other words, salvage value will be zero at the end of Year 4. If BIKE faces an opportunity cost of capital of 15 percent, when should it replace the machine?

As we said above, our approach is to compare the annual cost of the replacement machine with the annual cost of the old machine. The annual cost of the replacement machine is simply its *equivalent annual cost* (EAC). Let's calculate that first.

Equivalent Annual Cost of New Machine The present value of the cost of the replacement machine is as follows:

$$PV_{costs} = \$9{,}000 + \$1{,}000 \times PVIFA_{15\%,8} - \frac{\$2{,}000}{(1.15)^8}$$
$$= \$9{,}000 + \$1{,}000 \times (4.4873) - \$2{,}000 \times (.3269)$$
$$= \$12{,}833.5$$

Notice that the \$2,000 salvage value is an inflow. It is treated as a *negative* number in the above equation because it *offsets* the cost of the machine.

The EAC of a new machine equals:

$$PV/8\text{–year annuity factor at } 15\% = \frac{PV}{PVIFA_{15\%,8}} = \frac{\$12{,}833}{4.4873} = \$2{,}860$$

This calculation implies that buying a replacement machine is financially equivalent to renting this machine for \$2,860 per year.

Cost of Old Machine This calculation is a little trickier. If BIKE keeps the old machine for one year, the firm must pay maintenance costs of \$1,000 a year from now. But this is not BIKE's only cost from keeping the machine for one year. BIKE will receive \$2,500 at Date 1 if the old machine is kept for one year but would receive \$4,000 today if the old machine were sold immediately. This reduction in sales proceeds is clearly a cost as well.

Thus, the PV of the costs of keeping the machine one more year before selling it equals:

$$\$4{,}000 + \frac{\$1{,}000}{1.15} - \frac{\$2{,}500}{1.15} = \$2{,}696$$

That is, if BIKE holds the old machine for one year, BIKE does *not* receive the \$4,000 today. This \$4,000 can be thought of as an opportunity cost. In addition, the firm must pay \$1,000 a year from now. Finally, BIKE does receive \$2,500 a year from now. This last item is treated as a negative number because it offsets the other two costs.

While we normally express cash flows in terms of present value, the analysis to come is made easier if we express the cash flow in terms of its future value one year from now. This future value is:

$$\$2{,}696 \times 1.15 = \$3{,}100$$

In other words, the cost of keeping the machine for one year is equivalent to paying \$3,100 at the end of the year.[2]

Making the Comparison Now let's review the cash flows. If we replace the machine immediately, we can view our annual expense as \$2,860, beginning at the end of the year. This annual expense occurs forever, if we replace the new machine every eight years. This cash flow stream can be written as:

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	...

Expenses from replacing machine immediately	$2,860	$2,860	$2,860	$2,860	...

If we replace the old machine in one year, our expense from using the old machine for that final year can be viewed as $3,100, payable at the end of the year. After replacement, our annual expense is

The decision is easy once the charts of the two machines are compared. Would you rather make annual lease payments of $321.06 or $289.28? Put this way, the problem becomes a no-brainer. Clearly, a rational person would rather pay the lower amount. Thus, Machine *B* is the preferred choice.

Two final remarks are in order. First, it is no accident that we specified the costs of the tennis ball machines in real terms. While *B* would still have been the preferred machine had the costs been stated in nominal terms, the actual solution would have been much more difficult. As a general rule, always convert cash flows to real terms when working through problems of this type.

Second, the above analysis applies only if one anticipates that both machines can be replaced. The analysis would differ if no replacement were possible. For example, imagine that the only company that manufactured tennis ball throwers just went out of business and no new producers are expected to enter the field. In this case, Machine *B* would generate revenues in the fourth year whereas Machine *A* would not. Here, simple net present value analysis for mutually exclusive projects including both revenues and costs would be appropriate.

The General Decision to Replace

The previous analysis concerned the choice between Machine *A* and Machine *B*, both of which were new acquisitions. More typically, firms must decide when to replace an existing machine with a new one. This decision is actually quite straightforward. One should replace if the annual cost of the new machine is less than the annual cost of the old machine. As with much else in finance, an example clarifies this approach better than further explanation.

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Consider the situation of BIKE, which must decide whether to replace an existing machine. BIKE currently pays no taxes. The replacement machine costs $9,000 now and requires maintenance of $1,000 at the end of every year for eight years. At the end of eight years, the machine would be sold for $2,000.

The existing machine requires increasing amounts of maintenance each year, and its salvage value falls each year, as shown:

YEAR	MAINTENANCE	SALVAGE
Present	$ 0	$4,000
1	1,000	2,500
2	2,000	1,500
3	3,000	1,000
4	4,000	0

This chart tells us that the existing machine can be sold for $4,000 now. If it is sold one year from now, the resale price will be $2,500, and $1,000 must be spent on maintenance during the year to keep it running. For ease of calculation, we assume that this maintenance fee is paid at the end of the year. The machine will last for four more years before it falls apart. In other words, salvage value will be zero at the end of Year 4. If BIKE faces an opportunity cost of capital of 15 percent, when should it replace the machine?

As we said above, our approach is to compare the annual cost of the replacement machine with the annual cost of the old machine. The annual cost of the replacement machine is simply its *equivalent annual cost* (EAC). Let's calculate that first.

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$$PV_{costs} = \$9{,}000 + \$1{,}000 \times PVIFA_{15\%,8} - \frac{\$2{,}000}{(1.15)^8}$$
$$= \$9{,}000 + \$1{,}000 \times (4.4873) - \$2{,}000 \times (.3269)$$
$$= \$12{,}833.5$$

Notice that the $2,000 salvage value is an inflow. It is treated as a *negative* number in the above equation because it *offsets* the cost of the machine.

The EAC of a new machine equals:

$$PV/8\text{–year annuity factor at } 15\% = \frac{PV}{PVIFA_{15\%,8}} = \frac{\$12{,}833}{4.4873} = \$2{,}860$$

This calculation implies that buying a replacement machine is financially equivalent to renting this machine for $2,860 per year.

Cost of Old Machine This calculation is a little trickier. If BIKE keeps the old machine for one year, the firm must pay maintenance costs of $1,000 a year from now. But this is not BIKE's only cost from keeping the machine for one year. BIKE will receive $2,500 at Date 1 if the old machine is kept for one year but would receive $4,000 today if the old machine were sold immediately. This reduction in sales proceeds is clearly a cost as well.

Thus, the PV of the costs of keeping the machine one more year before selling it equals:

$$\$4{,}000 + \frac{\$1{,}000}{1.15} - \frac{\$2{,}500}{1.15} = \$2{,}696$$

That is, if BIKE holds the old machine for one year, BIKE does *not* receive the $4,000 today. This $4,000 can be thought of as an opportunity cost. In addition, the firm must pay $1,000 a year from now. Finally, BIKE does receive $2,500 a year from now. This last item is treated as a negative number because it offsets the other two costs.

While we normally express cash flows in terms of present value, the analysis to come is made easier if we express the cash flow in terms of its future value one year from now. This future value is:

$$\$2{,}696 \times 1.15 = \$3{,}100$$

In other words, the cost of keeping the machine for one year is equivalent to paying $3,100 at the end of the year.[2]

Making the Comparison Now let's review the cash flows. If we replace the machine immediately, we can view our annual expense as $2,860, beginning at the end of the year. This annual expense occurs forever, if we replace the new machine every eight years. This cash flow stream can be written as:

YEAR 1	YEAR 2	YEAR 3	YEAR 4	...

Expenses from replacing machine immediately	$2,860	$2,860	$2,860	$2,860	...

If we replace the old machine in one year, our expense from using the old machine for that final year can be viewed as $3,100, payable at the end of the year. After replacement, our annual expense is

$2,860, beginning at the end of two years. This annual expense occurs forever if we replace the new machine every eight years. This cash flow stream can be written as: page 250

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	...
Expenses from using old machine for one year and then replacing it	$3,100	$2,860	$2,860	$2,860	...

Put this way, the choice is a no-brainer. Anyone would rather pay $2,860 at the end of the year than $3,100 at the end of the year. Thus, BIKE should replace the old machine immediately in order to minimize the expense at Year 1.

Two final points should be made on the decision to replace. First, we have examined a situation where both the old machine and the replacement machine generate the same revenues. Because revenues are unaffected by the choice of machine, revenues do not enter into our analysis. This situation is common in business. For example, the decision to replace either the heating system or the air-conditioning system in one's home office will likely not affect firm revenues. However, sometimes revenues will be greater with a new machine. The above approach can easily be amended to handle differential revenues.

Second, we want to stress the importance of the above approach. Applications of the above approach are pervasive in business, since *every* machine must be replaced at some point.

SUMMARY AND CONCLUSIONS

This chapter discusses a number of practical applications of capital budgeting.

1. Capital budgeting must be done on an incremental basis. This means that sunk costs must be ignored, while both opportunity costs and side effects must be considered.
2. In the Baldwin case, we computed NPV using the following two steps:
   a. Calculate the net cash flow from all sources for each period.
   b. Calculate the NPV using the cash flows calculated above.
3. Inflation must be handled consistently. One approach is to express both cash flows and the discount rate in nominal terms. The other approach is to express both cash flows and the discount rate in real terms. Conceptually either approach yields the same NPV calculation. However, in practice, nominal values are mostly used.
4. There are different approaches to calculate operating cash flow that measure the same thing.
5. A firm should use the equivalent annual cost approach when choosing between two machines of unequal lives.

CONCEPT QUESTIONS

1. **Opportunity Cost** In the context of capital budgeting, what is an opportunity cost?
2. **Incremental Cash Flows** Which of the following should be treated as an incremental cash flow when computing the NPV of an investment?

- **a.** A reduction in the sales of a company's other products caused by the investment.
- **b.** An expenditure on plant and equipment that has not yet been made and will be made only if the project is accepted.
- **c.** Costs of research and development undertaken in connection with the product during the past three years.

d. Annual depreciation expense from the investment.

e. Dividend payments by the firm.

f. The resale value of plant and equipment at the end of the project's life.

g. Salary and medical costs for production personnel who will be employed only if the project is accepted.

3. **Incremental Cash Flows** Your company currently produces and sells steel shaft golf clubs. The board of directors wants you to consider the introduction of a new line of titanium bubble woods with graphite shafts. Which of the following costs are *not* relevant?

   a. Land you already own that will be used for the project, but otherwise will be sold for $700,000, its market value.

   b. A $300,000 drop in your sales of steel shaft clubs if the titanium woods with graphite shafts are introduced.

   c. $200,000 spent on research and development last year on graphite shafts.

4. **Depreciation** Given the choice, would a firm prefer to use MACRS depreciation or straight-line depreciation? Why?

5. **Net Working Capital** In our capital budgeting examples, we assumed that a firm would recover all of the working capital it invested in a project. Is this a reasonable assumption? When might it not be valid?

6. **Stand-Alone Principle** Suppose a financial manager is quoted as saying, "Our firm uses the standalone principle. Because we treat projects like minifirms in our evaluation process, we include financing costs because they are relevant at the firm level." Critically evaluate this statement.

7. **Equivalent Annual Cost** When is EAC analysis appropriate for comparing two or more projects? Why is this method used? Are there any implicit assumptions required by this method that you find troubling? Explain.

8. **Cash Flow and Depreciation** "When evaluating projects, we're only concerned with the relevant incremental aftertax cash flows. Therefore, because depreciation is a noncash expense, we should ignore its effects when evaluating projects." Critically evaluate this statement.

9. **Capital Budgeting Considerations** A major college textbook publisher has an existing finance textbook. The publisher is debating whether or not to produce an "essentialized" version, meaning a shorter (and lower-priced) book. What are some of the considerations that should come into play?

   To answer the next three questions, refer to the following example. In 2003, Porsche unveiled its new sports utility vehicle (SUV), the Cayenne. With a price tag of over $40,000, the original Cayenne went from 0 to 62 mph in 9.7 seconds. Porsche's decision to enter the SUV market was in response to the runaway success of other high-priced SUVs such as the Mercedes-Benz M-class. Vehicles in this class had generated years of very high profits. The Cayenne certainly spiced up the market, and Porsche subsequently introduced the Cayenne Turbo S, which goes from 0 to 62 mph in 3.8 seconds and has a top speed of 176 mph. The price tag for the Cayenne Turbo S in 2016? Over $157,000!

Some analysts questioned Porsche's entry into the luxury SUV market. The analysts were concerned not only that Porsche was a late entry into the market, but also that the introduction of the Cayenne would damage Porsche's reputation as a maker of high-performance automobiles.

10. **Erosion** In evaluating the Cayenne, would you consider the possible damage to Porsche's reputation as erosion?

11. **Capital Budgeting** Porsche was one of the last manufacturers to enter the sports utility vehicle market. Why would one company decide to proceed with a product when other companies, at least initially, decide not to enter the market?

12. **Capital Budgeting** In evaluating the Cayenne, what do you think Porsche needs to assume regarding the substantial profit margins that exist in this market? Is it likely that they will be maintained as the market becomes more competitive, or will Porsche be able to maintain the profit margin because of its image and the performance of the Cayenne?

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The Replacement Market. The replacement market consists of all tires purchased after the automobile has left the factory. This market allows for higher margins, and Goodweek expects to sell the SuperTread for $59 per tire there. Variable costs are the same as in the OEM market.

Goodweek Tires intends to raise prices at 1 percent above the inflation rate; variable costs will also increase 1 percent above the inflation rate. In addition, the SuperTread project will incur $25 million in marketing and general administration costs the first year. This cost is expected to increase at the inflation rate in subsequent years.

Goodweek's corporate tax rate is 40 percent. Annual inflation is expected to remain constant at 3.25 percent. The company uses a 15.9 percent discount rate to evaluate new product decisions.

Automotive industry analysts expect automobile manufacturers to produce 2 million new cars this year and project that production will grow at 2.5 percent per year thereafter. Each new car needs four tires (the spare tires are undersized and are in a different category). Goodweek Tires expects the SuperTread to capture 11 percent of the OEM market. Industry analysts estimate that the replacement tire market size will be 16 million tires this year and that it will grow at 2 percent annually. Goodweek expects the SuperTread to capture an 8 percent market share. The appropriate depreciation schedule for the equipment is the seven-year MACRS schedule. The immediate initial working capital requirement is $11 million. Thereafter, the net working capital requirements will be 15 percent of sales.

a. What is the profitability index of the project?

b. What is the IRR of the project?

c. What is the NPV of the project?

d. At what OEM price would Goodweek Tires be indifferent to accepting the project? Assume the replacement market price is constant.

e. At what level of variable costs per unit would Goodweek Tires be indifferent to accepting the project?

CLOSING CASES

EXPANSION AT EAST COAST YACHTS

Since East Coast Yachts is producing at full capacity, Larissa has decided to have Dan examine the feasibility of a new manufacturing plant. This expansion would represent a major capital outlay for the company. A preliminary analysis of the project has been conducted at a cost of $1.2 million. This analysis determined that the new plant will require an immediate outlay of $55 million and an additional outlay of $30 million in one year. The company has received a special tax dispensation that will allow the building and equipment to be depreciated on a 20-year MACRS schedule.

Because of the time necessary to build the new plant, no sales will be possible for the next year. Two years from now, the company will have partial-year sales of $18 million. Sales in the following four years will be $27 million, $35 million, $39 million, and $43 million. Because the new plant will be more efficient than East Coast Yachts' current manufacturing facilities, variable costs are expected to be 60 percent of sales, and fixed costs will be $2.5 million per year. The new plant will also require net working capital amounting to 8 percent of sales for the next year.

Dan realizes that sales from the new plant will continue into the indefinite future. Because of this, he believes the cash flows after Year 5 will continue to grow at 3 percent indefinitely. The company's tax rate is 40 percent and the required return is 11 percent.

Larissa would like Dan to analyze the financial viability of the new plant and calculate the profitability index, NPV, and IRR. Also, Larissa has instructed Dan to disregard the value of the land that the new plant will require. East Coast Yachts already owns it, and, as a practical matter, it will simply go unused indefinitely. She has asked Dan to discuss this issue in his report.

BETHESDA MINING COMPANY

Bethesda Mining is a midsized coal mining company with 20 mines located in Ohio, Pennsylvania, West Virginia, and Kentucky. The company operates deep mines as well as strip mines. Most of the coal mined is sold under contract, with excess production sold on the spot market.

The coal mining industry, especially high-sulfur coal operations such as Bethesda, has been hard-hit by environmental regulations. Recently, however, a combination of increased demand for coal and new pollution reduction technologies has led to an improved market demand for high-sulfur coal. Bethesda has just been approached by Mid-Ohio Electric Company with a request to supply coal for its electric generators for the next four years. Bethesda Mining does not have enough excess capacity at its existing mines to guarantee the contract. The company is considering opening a strip mine in Ohio on 5,000 acres of land purchased 10 years ago for $5.4 million. Based on a recent appraisal, the company feels it could receive $7.3 million on an aftertax basis if it sold the land today.

Strip mining is a process where the layers of topsoil above a coal vein are removed and the exposed coal is removed. Some time ago, the company would simply remove the coal and leave the land in an unusable condition. Changes in mining regulations now force a company to reclaim the land; that is, when the mining is completed, the land must be restored to near its original condition. The land can then be used for other purposes. As they are currently operating at full capacity, Bethesda will need to purchase additional equipment, which will cost $43 million. The equipment will be depreciated on a seven-year MACRS schedule. The contract only runs for four years. At that time the coal from the site will be entirely mined. The company feels that the equipment can be sold for 60 percent of its initial purchase price. However, Bethesda plans to open another strip mine at that time and will use the equipment at the new mine.

The contract calls for the delivery of 500,000 tons of coal per year at a price of $60 per ton. Bethesda Mining feels that coal production will be 750,000 tons, 810,000 tons, 830,000 tons, and 720,000 tons, respectively, over the next four years. The excess production will be sold in the spot market at an average of $48 per ton, Variable costs amount to $21 per ton and fixed costs are $3.7 million per year. The mine will require a net working capital investment of 5 percent of sales. The NWC will be built up in the year prior to the sales.

Bethesda will be responsible for reclaiming the land at termination of the mining. This will occur in Year 5. The company uses an outside company for reclamation of all the company's strip mines. It is estimated the cost of reclamation will be $3.9 million. After the land is reclaimed, the company plans to donate the land to the state for use as a public park and recreation area as a condition to receive the necessary mining permits. This will occur in Year 5 and result in a charitable expense deduction of $7.3 million. Bethesda faces a 38 percent tax rate and has a 12 percent required return on new strip mine projects. Assume a loss in any year will result in a tax credit.

You have been approached by the president of the company with a request to analyze the project. Calculate the payback period, profitablitity index, net present value, and internal rate of return for the new strip mine. Should Bethesda Mining take the contract and open the mine?

[1] Our measure of net working capital is similar to the one derived from accounting statements except that current liabilities include only noninterest bearing liabilities. Interest bearing liabilities such as short-term bank debt are treated as invested capital (see Chapter 12 for more details). We also focus on these elements of net working capital that directly influence cash flows.

[2] One caveat is in order. Perhaps the old machine's maintenance is high in the first year but drops after that. A decision to replace immediately might be premature in that case. Therefore, we need to check the cost of the old machine in future years.

The cost of keeping the existing machine a second year is:

$$\text{PV of costs at Time 1} = \$2{,}500 + \frac{\$2{,}000}{1.15} - \frac{\$1{,}500}{1.15} = \$2{,}935$$

which has a future value of \$3,375 (= \$2,935 × 1.15).

The costs of keeping the existing machine for Years 3 and 4 are also greater than the EAC of buying a new machine. Thus, BIKE's decision to replace the old machine immediately is still valid.